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THE AMERICAN GAS LIGHT JOURNAL

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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

SECRETARY'S OFFICE, LYNN, MASS., Feb. 1, 1893.

The Twenty-third Annual Meeting of the New England Association of Gas Engineers will be held at Young's Hotel, Boston, on Wednesday and Thursday, February 15th and 16th, and will be called to order at 10 o'clock, Wednesday morning, the 15th.

The following papers will be read:

"Everyday Pyrometry," by Mr. Edward C. Jones, San Francisco Gas Light Company.

"Experiments on Removing Sulphur from Purified Gas," by Mr. George F. Goodno, Dedham and Hyde Park Gas Company.

"Reports," by Mr. Robert W. Bush, Boston Gas Light Company.

"Pressure Records on Mains and Services," by Mr. Samuel J. Fowler, Springfield Gas Light Company.

"Effects of the Trolley System on Gas and Water Pipes," by H. A. Allyn, Cambridge Gas Light Company.

It is expected that other papers will be presented whose titles will be announced later.

Applications for membership should be sent the Secretary in time to be acted upon by the Directors at their meeting, Tuesday evening, February 14th. Blank applications may be obtained of the Secretary.

C. F. PRICHARD, Secretary.

IN the communication by Mr. Egner, on the next page, add the following as a qualifying sentence, making it the sentence preceding the last one of the first paragraph: "Possibly Mr. Miller may have rated the calorific value of oil too low in his calculations."

BRIEFLY TOLD.

THE NEW ENGLAND CONCLAVE AT BOSTON.—From all that we can learn, and we have managed to glean considerable knowledge respecting the preliminary details of the Twenty-third Annual Meeting of the New England Association, it may be accepted as a certainty that those who are in Boston this week will participate in as good a meeting as any held by the mother of them all. All the routine matters connected with the affair have been put together and completed in the matter of fact way that marks the most, if not the whole, of Secretary Prichard's handiwork; and President Wood has had on his thinking cap for several weeks. Of course, we all know what must be the outcome of this session of "long continued and serious thought"—an address that will, when it has been absorbed by his hearers, cause them to ponder overmuch. We wish again to repeat our notice of a week ago, in the instance of inviting all the friends of the Association to be on hand at Young's next Wednesday; this, as we said last week, we are empowered to do by the Secretary, who will not mail any especial invitations.

LEGISLATIVE INTERFERENCE WITH THE GAS BUSINESS.—The Legislatures of no less than five States—there may be others, but we have positive knowledge of the five—New York, Nebraska, Massachusetts, Illinois and Pennsylvania—are considering matters of legislation that directly appeal to the interests of the gas makers. And although it is quite certain that the majority of the measures will fail of becoming laws, it is nevertheless true that all this activity indicates a feeling of more than unrest in the mind of the public respecting their attitude toward the gas suppliers and the attitude of the gas suppliers toward them. The public, rightfully or the reverse, according to the light in which one of the body wishes to look at the matter, have determined, apparently, that they have granted great "rights" to gas companies in permitting them to dig trenches in the streets for the purpose of placing mains therein, which no doubt would be, in fact is, a necessary formality and course to permit of the manufacture and distribution of gas; but the public also should bear in mind that their permission to open the streets is usually jealously hedged in with the provision that the streets must be immediately and permanently restored to their original condition. In fact, very frequently it happens that the surface of the street, when the same has been "restored" by the gas company, is in far better condition than it was before the company "disturbed" the same. The long and short of the great "rights" bestowed by the public upon gas companies amount to what we have tried to convey above—to that and nothing more; for, surely, the right to purchase land whereon to construct expensive buildings is inherent in anybody, as is also the privilege of paying a goodly sum in taxes on such land and buildings, to say nothing of the privilege of paying special taxes on capital stock, dividends, and so on. The main purpose of our present reference to this unmistakable ac-

tivity in legislation directed at gas interests is to again call attention to the need of the gas interests of the several States for legislation that shall originate with themselves, which legislation in our opinion should be directed towards the establishment of State Commissions. These look to be fair avenues leading to protection and comparative safety.

MR. EGNER REPLIES TO MR. MILLER.—The following to the JOURNAL, written by Mr. Frederic Egner, under date of St. Louis, Feb. 7th, explains itself:

To the Editor AMERICAN GAS LIGHT JOURNAL: Having read Mr. Miller's criticism of my article on the Harris process, and having the pleasure to be personally acquainted with the writer, and to know him to be an able and promising young engineer, I thought he possibly might have found a real mistake; hence I carefully looked over my notes to find it, and I did. For instead of 432.64 British heat units to a cubic foot of the gas, I found it should have been 433.015 heat units. Please make the correction. I shall not turn the matter off by writing, as Mr. Miller did, "Further comment is unnecessary," leaving the reader to infer what he pleased, but, with your permission, will still further explain the matter. In the article referred to it was stated that 1,000 cubic feet of the Harris gas, according to the analysis given me, contained:

Carbonic acid	48.5 cu. ft.
Olefiant gas and hydrocarbon vapors	86 0 "
Marsh gas	2.8 "
Carbonic oxide	222.9 "
Oxygen	3.5 "
Hydrogen	149 2 "
Nitrogen	487.1 "
Total	1,000 "

Authorities still differ as to the calorific value of many substances, but, quoting from the tables on the heating powers of gases before me, it is found that

One cu. ft. of	hydrogen will heat	343	lbs.	of water	1 degree.
" "	marsh gas	1,054	"	"	"
" "	heavy carb. hyd.	1,681	"	"	"
" "	benzine vapors (C_6H_6)	4,677	"	"	"
" "	carbonic oxide	355	"	"	"

It will be found by the tables in the article under discussion that the 86 cubic feet of olefiant gas and hydrocarbon vapors come to 34.2 cubic feet of C_2H_4 and 51.8 C_6H_6, and now we shall find that we have

Hydrogen	149.2	cu. ft. will develop	51,175.6	B.H.U.
Marsh gas	2.8	" "	2,951.2	"
Heavy carb. hydrogen	34.2	" "	57,490.2	"
Benzine vapors	51.8	" "	242,268.6	"
Carbonic oxide	222.9	" "	79,129.5	"
Oxygen	3.5	" "	....	
Carbonic acid	48.5	" "	....	
Nitrogen	487.1	" "	....	
Total	1,000		433,015.1	

Or, 433,015 per cubic foot, instead of 432.64, as was shown. I trust that your readers will believe with me that further comment was necessary. Furthermore, I desire to call attention to the fact that I did not claim nitrogen as an aid to combustion as my idea at all; though the thought of the gentleman whose idea it was, and whom I have not felt at liberty to name, was not an unreasonable one—if the matter is considered as it was stated. It was plainly stated that this gas would act as a conveyer of heat, probably, and not as an aid to combustion.—Yours truly, F. EGNER.

NOTES.—A solemnly beautiful ceremony was that celebrated at St. Patrick's Cathedral, this city, on the morning of Wednesday last, when Miss Alice C. Enfer, daughter of Mr. and Mrs. E. J. Enfer, of New York, was united in marriage to Mr. Harry E. Floyd, a worthy son of Mr. James R. Floyd, known to and respected by the gas fraternity the country over. The union was pronounced by Archbishop Corrigan, and in every sense the ceremony was impressive and harmonious. May complete happiness be their portion.——The Middletown (N. Y.) Gas and Electric Light Company has again come under the control of local capitalists. A water gas annex will be installed there.——The proprietors of the Milwaukee Gas Stove Company inform us that notwithstanding the conflagration at their plant, which was reported in last week's JOURNAL, they are ready to receive orders, which will be filled from quarters temporarily operated, or until the works proper are rehabilitated. This latter will be speedily accomplished.

Recent Results of Municipal Gas Making in the United States.

[A paper contributed by Professor Edward W. Bemis, Ph.D., to the *Review of Reviews*.]

The object of the present article is to give the actual results of the last fiscal year of city owned gas works in this country, as obtained in nearly every case by recent personal visits of the writer to the ten places so owning, and in every instance from official records and other reliable data. The facts presented seem to answer the challenge of a writer in the August *Forum:* "To point out any American city where any municipal work is done so economically or so well as similar work is done by private individuals."

The first fact to be noted is that there was much dissatisfaction with the quality or price of the gas furnished by the private companies in Danville, Fredericksburg and Charlottesville, Va., Henderson, Ky., Hamilton, Ohio., and Wheeling, W. Va., before the city purchased and improved the works. In these same cities now, and in the other four that built their works, Philadelphia, Richmond, Bellefontaine, Ohio, and Alexandria, Va., there is very hearty approval of city ownership on the part of fully four-fifths and apparently nine tenths of the people. In several cities of late, flattering offers for purchase by private companies have been rejected without hesitation. So well pleased are Danville, Alexandria, Charlottesville and Wheeling with public ownership of their gas works that they have recently constructed electric light works, and great success has attended the two cities, Danville and Alexandria, which have completed a year of public management of such works.

The price of gas in Henderson is $1.25. Only one of the twenty private companies in Kentucky charges as little. The price in the two Ohio cities, neither of them large, owning their works is $1, but as this goes to press I notice in one of the leading gas journals that in one of these, Bellefontaine, the price has just fallen to 80 cents. Of the 74 cities having private works which report to Brown's Directory of American Gas Companies for 1892, only six get all their illuminating gas as low as $1. Four charge just $1. Cleveland has just been forced by the City Council to reduce its charge to 80 cents, and the sixth, New Lisbon, sells an oil or water gas for 40 cents. The only city of any size known to the writer, besides Cleveland, which gets its gas as low as Wheeling, where the public works sell at a profit for 75 cents, is Terre Haute, Ind., where a fierce but seemingly temporary war between two companies has reduced the price of water gas, in the case of one company, and of a combined water and oil gas in that of the other, to 35 cents. In a similar gas war at Kokomo, Ind., one company was even giving away its gas during the last quarter of 1892. No instance is on record of where such competion has not been followed by consolidation and a rise of prices.

Of the five cities that own their works in Virginia, Charlottesville and Fredericksburg charge $1.50, Alexandria, $1.44, Richmond and Danville, $1.25. Of the seven cities which have private works, of which five are larger than any of the cities, save Richmond, having public works, only one city enjoys a lower price than $1.60. Norfolk charges $1.40.

From a careful examination of the charges for gas throughout the country I think it can safely be said that, with the exception of Philadelphia, for whose high price of $1.50 special reasons exist, the price in these public companies is lower than in most private ones similarly circumstanced in amount of population, cost of coal and price obtainable for coke and tar.

The candle power of the gas—hitherto entirely coal gas save in Philadelphia, where 40 per cent. is water gas—ranges from 17 to 18, except in Philadelphia and Wheeling, where it is 19. The introduction of a supplementary water gas plant, owned by the city, in Hamilton and Bellefontaine last year, and the increased use of water gas in Philadelphia, is likely to raise the candle power in these places soon to 21 or 22. The average candle power of the Massachusetts companies in 1891 was 18.13.

While giving low prices, the public companies are yearly increasing their efficiency out of their earnings, and, in addition to such taxes as a private company would have to pay, they are earning a good profit on the cost of duplication. This profit varies from 10 to 20 per cent. in six cities, and from 6 to 8 per cent. in three others, as follows: Philadelphia, 20; Charlottesville, 17 (average of last two years); Richmond, 18; Henderson, 12; Wheeling, 11.6; Alexandria, 9.8; Hamilton, 7.7; Danville, 7; Bellefontaine, 6.2, and Fredericksburg, 1.2. In reaching these figures the gas used by the city and not directly paid for, save in part in Hamilton and wholly in Fredericksburg, is reckoned at the same

price as if sold to private consumers. Fredericksburg, after the thorough overhauling which she is giving her newly purchased works, will doubtless show a fair profit in two or three years. As it is, her purchase of the works in September, 1891, resulted in an immediate reduction in price from $3 to $1.50. Similarly the construction of works by Hamilton in April, 1890, led to an immediate reduction of price there from $2 to $1.

One good test of the relative efficiency of works is the percentage of leakage. Now, the average rate per cent. of leakage in the 58 private Massachusetts companies that deliver to the consumer was 11.66 in 1891, and in the public companies precisely the same, if the small town of Fredericksburg be omitted. This place bought out private works that had a leakage of over 30 per cent., and in its first year has reduced the leakage nearly one-half, but has not yet, of course, gotten it down to what it should be. Including Fredericksburg the average rate was 12.3.

Such excellent financial results have been accompanied by a decrease rather than, as many who have not investigated the facts believe, an increase of political corruption. Superintendent W. C. Adams, of Richmond, Va., has held his place since 1886, and before that was Assistant Superintendent for 16 years. Supt. Wm. Cannings, at Henderson, Ky., has held his office ever since the city changed from leasing to operating its works in 1882. In 1891 the Superintendent of the Alexandria, Va., works died after 30 years' service. Capt. C. A. Ballou had been City Engineer and Superintendent of the Danville, Va., gas and water works for 18 years. In Charlottesville, Supt. J. T. Williams has had charge since the city bought the works in 1876, and had been serving in a similar capacity under the private company for 21 years before. When Fredericksburg, Va., recently bought out the private gas plant, the old and capable Superintendent, Mr. David E. Fleming, was retained, though unfortunately at somewhat reduced salary. The trustees of the Hamilton works are non-partisan, and men of both parties are employed, as in the other works. At Bellefontaine, Ohio, the Superintendent has held office for many years, and the entire management is non-partisan. At Wheeling, W. Va., Mr. S. M. Darrah has been Superintendent since 1884, except 1886 and 1888, when the former Superintendent, Mr. Dillon, was tried again.

Politics seem to have cut no figure in Philadelphia since 1887 in the appointment of the chief men of the gas department, while civil service rules have been pretty effectually applied to the subordinates. It was not always so in Philadelphia. For 46 years prior to 1887 the city was legally unable to shake off a most unfortunate form of government, in which the gas management was in the hands of a body of trustees elected by the Council, but subject to no control or investigation by them. By the terms of the charter, this form of government could not be changed until certain portions of the debt were paid. Naturally great misgovernment followed, yet as great political corruption, probably, was exposed in connection with the private gas companies of New York by an investigating committee of the New York Senate in 1885 (Senate Document 41). In all but six years of the time, 1841–1886, the price of gas was higher in New York than in Philadelphia. Since 1887 the entire system has been changed for the better in the latter city. There are still some employees, I found, not by any means all, who suppose it to be their personal interest to keep the present parties in power by work at the primaries. This is also true to some extent at Wheeling, and possibly at Richmond, but the heads of the departments in each of these places declared that there was a steady growth of sentiment in favor of making the employees perfectly secure in their places on good behavior, as is undoubtedly the case to-day in most of the ten cities under discussion.

When one of the best informed citizens of the Quaker City was recently asked by me which now exerted the greatest political influence, the public-owned gas works or the private street car lines, he replied at once: "Oh, the street car lines, undoubtedly; they own the city, body and soul." The fact seems to be that the general public realizes that the work of gas manufacture is too technical and important to be intrusted to new, green hands every time there is a change in politics, and city ownership has been put to a fair, if not very extensive, test in the matter; for, though only one of the great parties usually controls the Virginia cities and some of the others that own gas works, yet there are often in these cities bitter contests of rival factions and great temptations for using the gas works politically. That the sentiment against it has been so successful and is so rapidly growing is very encouraging. One reason for the poor quality of administrative material is the little power given an official. Increase it, and stronger characters are willing to accept place and are able to command it.

Then, too, it must not be forgotten that political corruption is not confined to public-owned companies. The extent to which quasi-public monopolies in private hands are tempted—and sometimes by the raids of unscrupulous politicians almost forced—to bribe and control councils and the press, is one of the most potent and widespread evils of our political system. Yet how few really grasp the magnitude of the evil!

City ownership saves many illegitimate expenses of this kind and many high salaries and dividends on new capitalization, while sometimes, but by no means in the majority of cases, it slightly increases the labor cost.

Only two of the ten superintendents of public companies say that they are hampered in getting any improvements really needed. More than one gas engineer of experience, working now for large private companies, expresses the belief that the public companies average as well as the private in introducing improvements. This point is, of course, difficult to settle, because of too little accessible evidence. It would appear, however, that whether or not public companies can, by reason of lower rates of interest, fewer large salaries and expenditures for politics and "influence," manufacture as cheaply as private companies, certainly the public generally get more benefit from city-managed companies in the way of lower charges or more net revenue, or both, than from the private companies.

Only one of the private companies seems now resting under any suspicion—namely, Hamilton, Ohio. Although information gathered on a visit to the city, August, 1892, from well-informed, disinterested parties, leads the writer to believe that five out of six of the people of Hamilton believe in the city management of its gas works, yet a few critics, urged on, it is charged, by private gas companies, who generally fight city ownership, instituted an examination last spring, by a Cincinnati engineer. He criticised the method of bookkeeping of the clerk of the works, Mr. Willard Smyers, who seems to be, on the whole, doing excellently, but brought no charge of corruption or mismanagement against any one. Only by large allowance for depreciation does the investigator make it appear that the works at $1 a thousand feet are not fully paying interest and such taxes as a private company would have to pay. While the report institutes no comparison between the first and second year, just closed, of city ownership, it contains material for so doing, which is very favorable to Hamilton and most promising for the future.

From the statements of this expert or from simple computations based on them, it appears that the cost of putting gas in the burner, aside from interest, taxes and depreciation, was 74.6 cents per 1,000 the first fiscal year, April 29, 1890, to February 28, 1891, and 42.5 cents the last fiscal year, March 1, 1891, to February 29, 1892. During the past year the cost in the holder was 42.2 cents. The interest at 5 per cent., which the city pays, on $173,408, the cost of construction, amounted to 41 cents per 1,000 the first year, and 22.1 cents the second. The taxes a private company would have had to pay were 5.8 cents the first year and 4.3 cents the second. The total cost thus, aside from depreciation, was 121.4 cents the first year and 80.7 cents the second. The gas used increased from 22,409,700 feet the first fiscal year of 10 months to 35,388,700 feet the second, while the leakage fell from 16.8 per cent. to 8.1 per cent. Inasmuch as the output of gas increased 27.5 per cent. March 1 to August 31, 1892, over the corresponding six months the previous year, without corresponding increase in cost, the figures for 1892–93 are not likely to exceed 70 cents for the above items. The Cincinnati investigator added for depreciation about 4½ per cent. on the capital. To be precise, he added 2 per cent. on the cost of the buildings, 7 per cent. on the mains, 10 per cent. on "sundry expenses for construction," 8 per cent. on salaries, 5 per cent. on street lamps (which are no part of a gas plant proper), and 10 per cent. on meters. Where the works are well kept up and the real estate is increasing in value, as at Hamilton, the above allowance for depreciation is thought by some engineers excessive. But, even if admitted, it only adds to the first year's cost 27.4 cents, and to the second year 20.8 cents, making the total cost the first year 148.8 cents, and the second year 101.5 cents, which will surely be below 90 cents, and probably below 85 cents, in 1892–93. After a couple of years, new construction can be charged to running expenses at Hamilton, as at the other places. No allowance need then be made for depreciation, as long as the efficiency of the works gradually increases.

Much is expected at Hamilton from the new water gas plant there, which was to be ready for use by December, 1892. It has a capacity of 360,000 feet daily, and in the hands of two private companies north of the Ohio river is said, on good authority, to be putting gas in the holder for 20 to 22 cents per 1,000 feet.

Hamilton is the only one of the 10 gas owning cities where the original private company, if there were one, was not bought out by the city. The refusal of the private company at Hamilton to place a fair value

upon its plant is said to have been the cause, but serious embarrassments have come to the city in consequence of a competing private company. The price of gas has been reduced from $2 to $1, and the private company has been led to seek most of its revenue from electric light and gas engines, but the city has been subjected to tedious and costly litigation. Then, too, competition in the gas business increases the expense of gas manufacture. There is a waste of capital and labor in keeping up two plants where one would do better if properly managed. Despite these difficulties Hamilton has already, in the first 1½ years of city ownership, achieved great success.

Although the far greater area of Philadelphia than of New York renders the cost of distribution much greater in the former, and although the Quaker City has not yet wholly recovered from the blight of the gas trust prior to 1887, yet the city gains more from public management than does New York from private, and with probably less political corruption. In 1891, with the price of gas at $1.50, coal averaging $3.56 per short ton, and coke 5½ cents per bushel, the net receipts in Philadelphia were $947,797.39. If to this we add the 587,398,328 feet of gas used in the streets and public buildings at $1.50, we have $881,097.49 more, or a total of $1,828,894.88. This is 24 per cent. of the $7,600,000 which, as near as can be estimated, would duplicate the entire coal gas plant. A deduction of 2 per cent. for taxes, and 4 per cent. for interest (though the city pays no taxes, and the works are nearly out of debt) would leave 18 per cent. net profit.

In New York the price to private consumers is $1.25, and to the city a little less, but more, if I am correctly informed, than $1. Besides this, and taxes, the city gets nothing. Now suppose we estimate the net profits in Philadelphia, if the gas to private consumers has been sold at $1.25 and to the city at $1. The profit would then have been $965,832.61, or 12.7 per cent. Deducting 6 per cent. for interest and taxes, there would have been 6.7 per cent., or $509,200 net profit. With as large a population and gas consumption as New York, the net profit would easily be twice as great, on the somewhat higher candle power there. Right here it should be added that this profit is only estimated after including the cost of gas, the $274,124.31 spent for extensions, as well as liberal amounts spent for repairs. The cost in the holder at Philadelphia, of the coal gas made by the city, is 48 cents.

The city buys a large amount of water gas (about 40 per cent. of all the gas used) from a private company for 37 cents in the holder. The cost of making each gas, and especially water gas, is rapidly falling, and the Philadelphia authorities are urgent for city ownership of the water gas plant; for water gas is of late becoming so perfected as to be much cheaper than coal gas, and quite as good. The illuminating power is better. Complaints were raised a year ago in Philadelphia against the water gas plant in a part of the city where, according to ex-Superintendent Wagner, none was used. Better street mains and more of the latest improved retorts are the great need, and are being gradually supplied. The cost of putting gas in the burner, including extensions, but not interest or taxes, has fallen from $1.17 to 85½ cents from 1886 to 1891, and should soon be down to 60 cents.

The price of gas is kept at $1.50 because the unusually large numbers of small house owners in Philadelphia, on whom the burden of local taxation now falls, in the absence of any taxation of the rich, desire relief from taxes. Were it not for the income from the gas and water works, the rate of taxation would have to be 60 cents(!) higher on the $1. The price is kept nearer the cost in the other nine gas owning cities.

A more favorable showing is presented at Wheeling, which has not been handicapped like Philadelphia by an inheritance of a long early period of mismanagement under an irresponsible gas trust. If all new construction and extension be included under cost of gas in the burner, the total cost, irrespective of any interest or taxes, which Wheeling does not have to pay, was 40 cents in 1889-90; 46 cents in 1890-91 and 35.3 cents in 1891-92. The cost, aside from extension, was 34.3 cents the first of these years, 29.7 cents the second and 29.5 cents the last year. Even an allowance of 7 per cent. on the cost of duplication, for interest and taxes, would only raise the cost to about 61 cents in 1889-90, 67 cents in 1890-91, and 57 cents in 1891-92. Selling gas to private consumers at 75 cents and furnishing free all gas used by the city (worth at 75 cents $23,129), the city in 1891 and 92 made about $28,000 in cash.

It should be noted that coal, in this city of 35,000 (1890) population, costs only $1.45 per ton, or 16.9 cents per 1,000 feet in the holder. This, however, is only 20 cents to 30 cents less than in most cities east of the Mississippi, and less than 10 cents per 1,000 feet below the cost in most cities in Ohio or Western Pennsylvania and near the lakes and Ohio river. The value of coke, tar and ammoniacal liquor was from 16 to 18 cents per 1,000 feet in the burner in each of the last three years, which is not larger than in many cities. The works under the able management of Mr. S. M. Darrah, who has charge since 1884, excepting the years 1886-88, when a former superintendent was again tried, appear in excellent condition.

Cleveland, a much larger city, is happy over securing gas for 80 cents from a private company with 6½ per cent. of the gross receipts, making the not cost about 72 cents. But it was only on condition of 10 years' contract, during which time the cost of gas may be expected to fall over one-half. Even to-day, Wheeling could sell at 72 cents and make, on the basis of the average cost of the last three years, 11 per cent. without taxes, and 9 per cent. with them.

Bellefontaine, O. This town of about 5,000 population, which has managed its gas works successfully since 1873, furnishes a striking example of the possibilities of cheap gas and of the fact that progressiveness is not by any means confined to private owned works. After full trial, the town has paid $10,000 for a new plant, known as the Askins gas plant, which has a capacity of 126,000 feet per day of 22-candle power, or 46,000,000 feet a year, if the daily consumption were uniform, at a cost per 1,000 feet in the holder of less than 20 cents. Interest and taxes even at 10 per cent. would not add 10 cents to this. The cost of distribution varies from 10 to 30 cents in different places. Competent engineers who have examined the plant confirm the claims of the inventor.

It is a somewhat similar plant, known as the Kendall process, which is now being introduced in the city owned works at Hamilton, O. The results in these two places, being open to public investigation, will be watched with interest. At Lakewood, N. Y., on Lake Chautauqua, excellent gas has been made out of benzine for four years by passing steam and oil through very hot firebrick, first heated by steam and a little oil forced through by a draft. The cost of putting the gas in the holder, even with the very small holder and output there, has not exceeded 30 cents. In the Askins process at Bellefontaine there are two generators. In the first generator crude Lima oil (about 5 gallons at 1¼ cents a gallon for every 1,000 feet) is fed into a bed of incandescent coke, underlying heated soft coal, which feeds it. Steam is admitted at the bottom of the generator. The result is a hydrocarbon vapor, which passes into the second generator, where it meets water gas resulting from the passage of steam through incandescent coke. The mingled vapors and gases are then converted into good illuminating gas in intensely hot retorts. This, after some purification, is delivered into the holder.

An interesting comparison is that between Richmond, Va., under public ownership, and Nashville, Tenn., under private. Richmond

Table I.

Place.	1 Date of Beginning of Ownership.	2 Population in 1890.	3 Fiscal Year from which Returns are Given.	4 Cost of Coal per Long Ton.	5 Price of Coke per Bushel.	6 Price of Tar per Barrel of 50 Gallons.
Philadelphia	1841	1,046,964	Jan. 1 to Dec. 31, 1891	$4 00	5.5 to 6 cents.	*
Richmond, Va.	1852	81,388	Jan. 1 to Dec. 31, 1891	4 60	6 cents.	$1 32
Alexandria, Va.	1853	14,330	June 1, 1891—May 31, 1892.	3 82	6.25 "	2 00
Henderson, Ky.	1867	8,835	June 1, 1891—May 31, 1892.	2 61	8 6 "	2 03
Wheeling, W. Va.	1870	35,013	April 1, 1891—Mar. 31, 1892.	1 64	3.5 "	3 00
Bellefontaine, Ohio	1873	4,238	Jan. 1—Dec. 31, 1891	3 34	8.5 to 10 cents.	3 00
Danville, Va.	1876	10,305	Jan. 1—Dec. 31, 1891	4 39	10 cents.	2 35
Charlottesville, Va.	1876	5,562	July 1, 1891—June 31, 1892	3 75	10 "	2 00
Hamilton, Ohio	1890	17,565	Mar. 1, 1891—Feb. 29, 1892.	2 59	6 "	3 90
Fredericksburg, Va.	1891	4,528	Sept. 1, 1891—June 31, 1892.	4 25	8 "	3 00

* Tar in Philadelphia sells for 37 cents per ton of coal carbonized.
Tar reduced in 1892 to $1.70 in Hamilton.

Table II.

Place.	Cost of Coal, per 1,000 Feet, in Holder.	Value of all Residuals, per 1,000 Feet, in Holder.	Leakage.	Net Cost per 1,000 Feet in Burner, save Improvements, Extensions, Interest, and Taxes.
Philadelphia	40.0 cents.	14.6 cents.	14.72 per cent.	76.0 cents.
Richmond	28.1 "	11.0 "	16.00 "	79.5 "
Alexandria	32.8 "	11.2 "	12.40 "	82.8 "
Henderson	29.1 "	14.6 "	12.00 "	58.1 "
Wheeling	15.2 "	15 4 "	10.25 "	29.5 "
Bellefontaine	36.1 "	15.1 "	6.42 "	57.7 "
Danville	45.0 "	11.8 "	19.00 "	92.5 "
Charlottesville	.....	11.0 "	6.07 "	46.5 "
Hamilton	31.0 "	23.0 "	8.08 "	52.4 "
Fredericksburg	44.2 "	11.4 "	18.00 "	127.1 "

Table III.

Place.	1. Cost per Burner of Extensions.	2. Cost, Including Extensions.	3. Gas Consumed in Burner.	4. Cost of Duplication.	5. Capital per 1,000 Feet in Burner.
Philadelphia	9.5	85.5 cents.	2,857,994,228	$8,400,000	$2 94
Richmond	4.8	84 3 "	184,320,000	600,000	3 30
Alexandria	11.5	94.3 "	19,111,157	76,000	4 18
Henderson	0	58.1 "	13,004,900	60,000	4 62
Wheeling	5.8	35.4 "	138,598,140	400,000	2 91
Bellefontaine	7.0	63.7 "	9,541,100	45,000	4 40
Danville	17.2	107.7 "	11,908,300	57,000	4 67
Charlottesville	0	46.5 "	7,625,074	34,000	4 46
Hamilton	Or cost of duplication included in capital.	Extension omitted. 52.4 cents.	35,388,700	173,400 / 25,000	4 90
Fredericksburg	Included in capital	127.1 "	10 months. 2,665,730	.....	On a year's output, about $8 00

The cost of duplicating the Philadelphia plant is based on most liberal estimates, and covers an allowance of $800,000 for the private water gas plant with a maximum daily capacity of 11,000,000 feet. Over $3,000,000 is the value of the land.

Table IV.

Place.	Par Value of Stock and Bonds per 1,000 Feet of Output of Gas.	Remarks.	Place.	Par Value of Stock and Bonds per 1,000 Feet of Output of Gas.	Remarks.
New York	$5 80	As one Company sends part of its gas to other Companies, only an approximation can be given.	Washington	$4 00	
Chicago	10 93		Buffalo	6 00	Returns from one of the three Companies not given.
Brooklyn	5 37		Rochester	9 09	
			St. Paul	8 70	
			Providence	4 95	
St. Louis	9 97		Troy	11 54	
New Orleans	20 25		Milwaukee	2 59	
San Francisco	14 58		Kansas City	2 30	
Cincinnati	7 00		Omaha	3 51	
Boston, including Dorchester, Roxbury and South Boston	6 53		Detroit	7 69	Returns from one Company not given.
Baltimore	14 53		Pittsburgh	4 17	Returns from one Company not given.
Louisville	7 31		Columbus	3 31	

Table V.

Place.	1 Profit per 1,000 Feet.	2 Amount of Interest at 5 per Ct. and Taxes at 2 per Ct.	3 Monopoly Profit per 1,000 Feet after Deducting Interest and Taxes	4 Price of Gas per 1,000 Feet.	5 Percentage of Monopoly of Profit and Interest on Cost of Duplication.	6 Percentage of Profit after Deducting Interest at 5 per Cent. and Taxes.
Philadelphia	64.5 cents.	20.6 cents.	43.9 cents.	$1 50	20.0 per ct.	15.0 per ct.
Richmond	65.7 "	23.1 "	42.6 "	1 50	18.0 "	13.0 "
Alexandria	49.7 "	29.3 "	20.4 "	1 44	9.8 "	4.8 "
Henderson	66 9 "	32.3 "	34.6 "	1 25	12.0 "	7.0 "
Wheeling	39.6 "	20.4 "	19.2 "	75	11.6 "	6.6 "
Bellefontaine	36.3 "	30.8 "	5.5 "	1 00	6.2 "	1.2 "
Danville	42.3 "	32.7 "	9.6 "	1 50	7.0 "	2.0 "
Charlottesville	103.5 "	38.8 "	64.7 "	1 50	21.6 "	16.6 "
Hamilton	47.6 "	34.3 "	13.3 "	1 00	7.7 "	2.7 "
Fredericksburg	22.9 "	47.0 " 10 months.	24.1 "	1 50	1.2 "	5.8 "

(census of 1890) had 81,388 population ; Nashville only about 5,000 less. Practically the same proportion of colored and others not likely to use gas exists in the two. Coal in Richmond in 1891 was $4.60 a ton, or a third higher than in Nashville, and coke 6 cents a bushel, or one-third less, while, owing to leaks in the holder, which for some time could not be repaired, the cost of gas in the Virginia city was over 5 cents higher than it will be this year. Despite all this, Richmond selling gas at $1.50 as in Nashville, made above all expenses, including extensions, but not interest or taxes, the cash sum of $44,646.46. Besides this the city obtained free 51,122,600 feet for public use, which at $1.50 per 1,000 feet was worth $76,683.96. The total profit thus was $121,330 36, or equivalent to all the taxes paid by the Nashville Company ($18,847 30 in 1891) and 17 per cent. on $600,000, the cost, according to Superintendent Adams, of the Richmond gas works, of duplicating his plant. Fully 10 per cent., or $60,000, represents the net advantage of city ownership every year to Richmond as compared with Nashville. The price of gas was reduced in February at Richmond to $1.25, which is still 25 cents above all costs, including in costs interest and taxes, which Richmond does not have to pay. If the City Council grants Mr. Adams the $25,000 he has requested for a water gas plant the cost of manufacture will be further reduced.

In Table I. is given a list of the ten cities owning their gas works, with their population, date of beginning ownership, the fiscal year for which the further figures are given, the cost of coal per long ton, the price of coke per bushel and tar per barrel.

It thus appears that Philadelphia has owned her works 51 years, Richmond 40, Alexandria 39, Henderson 25, Wheeling 22, Bellefontaine 19, Danville and Charlottesville 16 years, Hamilton 2 years and Fredericksburg 1.

In Table II. are given very important items, the cost of coal and receipts for residuals per thousand feet in the holder, the leakage and the cost of gas per thousand feet in the burner, save extensions, interest, taxes and depreciation.

The figures for leakage, which include the amount used at the gas offices and works, will be 5 to 12 per cent. less this year in Richmond and Danville, and probably Fredericksburg, by the improvements already completed in holders and mains. In Philadelphia the published report gives the amount of leakage as 12.73 per cent., but this is the percentage of all the gas in the holders at the end of the year as well as of the gas sent out from them. Since the holders had also much gas at the beginning of the year, the percentage of leakage has been reckoned as in the other cities only on the gas made and in the holder at the end of the year, after subtracting that in holders at the beginning. Calculated on the same basis, the leakage in Philadelphia has fallen 1 per cent. the last year, and is likely to fall below 12 as soon as improvements now in contemplation are finished, but the great diffusion of the population of the city makes the length of pipe enormous for the gas used, and prevents a very low percentage of leakage being attained.

It will be noted that the residuals are from 11 to 15.4 cents in every city save Hamilton (23 cents), while coal costs from 28 to 45 cents per thousand feet in the holder, save in Wheeling, where the cost (15.2 cents) is a trifle below the price of the residuals.

The cost in the holder was 42.2 cents in Hamilton, and 48 cents in Philadelphia, in the case of the coal gas. A separation of costs in the holder from those of distribution has not been made in the other cities. The cost in the burner, with no allowance for extensions, depreciation, interest or taxes, was 29.5 cents in Wheeling, 46.5 cents in Charlottesville, from 52 to 58 cents in Hamilton, Bellefontaine and Henderson, and from 76 to 83 cents in Philadelphia, Richmond and Alexandria. In Danville the cost was 92.5 cents, and in Fredericksburg $1.27. The high price in the latter city is chiefly due to the small amount of gas used and the large leakage, heritage of the private company which was bought out a year ago. Since then the leakage has fallen about one-half, and the cost of gas making is sure to be further reduced there this year. In Danville, too, the large reduction in leakage now secured will reduce the cost of gas perhaps seven cents this year. As has already been said, the cost will also be materially less in most of the other cities.

In Table III. are given the cost per thousand feet in the burner of the extensions or new construction, and of the total cost when extensions, but not interest or taxes are included. There is also given the yearly consumption of gas, the cost of duplication of the plant or legitimate capital, and the amount of this for every thousand feet of gas used.

The value of the plant aside from the land is under $2 per thousand feet in the burner. The cost before improvements are added, as given in column 4 of Table II., was much less in the year given than in the year before. It had fallen 12 cents in Alexandria, 16.5 cents in Henderson, 7.2 cents in Wheeling, in Danville 22 cents, in Charlottesville, 25.5 cents. The cost in Philadelphia and Richmond remained about the same. The cost of extensions, as given in column 2 of Table III., was about the same as the year before, save that it was then 26.2 cents in Alexandria, 13 cents in Henderson, 16.3 cents in Wheeling and 12 cents in Charlottesville.

The increase in consumption was 3 per cent. in Philadelphia and 9 per cent. in the other cities. A somewhat similar yearly increase is taking place everywhere, and should be kept in mind by those who believe that electricity is destined to displace gas. The fact is that the illuminating power of gas and its cheapness of manufacture are keeping pace with the development of electric lighting. For every 10 feet of gas displaced by electric light on streets, and in halls, stores and some residences, 11 or more feet of gas are used in other residences or for fuel. People accustomed to brighter streets at night turn up the gas higher when they come home.

Very remarkable is the low cost of duplicating various city works as given in column 4 of Table III. The figures are, in nearly all cases, computed from the estimates of the gas superintendents. Usually the estimates were made by items, as, for example, the land, buildings, mains, meters and services, and the manufacturing apparatus. The works, of course, would be placed at a much higher price for purposes of sale, because of the large monopoly earnings, but reference is now made to cost of duplication in the present state of efficiency. Because of frequent additions to the works, the cost of a given size of street main, of a holder of any size, of retorts, purifying apparatus, meters, services, etc., can be pretty closely estimated. It appears that in the cities of over 20,000 inhabitants the cost of duplication runs from $2.91 to $3.30, and in all the other cities, save the small town of Fredericksburg ($8), it is below $5.

In competitive business where no very rare business talent is embodied, the value of the plant is, in the long run, the cost of duplication. If a person or corporation is earning more than the average profits on the cost of duplication in a competitive business where no great risks are run, or no very high order of ability is required, others will construct rival works and, by competition in selling the product, force down the profit to the normal rate on this cost of duplication. The value of the plant will then fall to the cost of duplication. In a monopoly like gas, where no very high order of ability is needed, and where there are no very great risks, the excess of capital over cost of duplication, which in cities of over 100,000 inhabitants is likely to range from $2.50 to $3.50, is a pretty good test of the monopoly profits. Very interesting it is, then, to note, in Table IV., the high capital of most of the following large cities. While the stock and bonds of some are not at par, there are other companies whose stock and bonds are above par, and the deduction to be made on the average for depreciation of the stock is probably in most cases covered by the fact that the capital has apparently, save in Boston, been reckoned on the basis of the output, instead of the consumption in the burner, a difference, of say, 10 per cent. in favor of the companies. The figures in the table are taken from Brown's Directory of American Gas Companies for 1892, save in the case of Boston. The figures there are taken from the Massachusetts Gas Commission's Seventh Annual Report. The bonds therein reported for the Boston, Dorchester, Roxbury and South Boston Companies, which are controlled by the Bay State Gas Company, of Delaware, are $4,560,000. In an argument by Henry M. Cross before the Committee on Manufactures of the Massachusetts Senate and House, February 18, 1892, the bonds are given as $7,000,000 first mortgage fives, $3,000,000 second mortgage fives, and $2,000,000 income sevens. Such figures would double the capitalization per thousand feet for Boston, given in the table.

Returns are not at hand for Minneapolis, Cleveland, Syracuse, Albany and New Haven. The average capital of the 22 large cities given is $7.72. The capital of the 18 having more than $3.99 capital each, which embraces all the largest cities, is $8.78 on the output of 1891. On this over capitalization the private companies, through their monopoly, are on the whole successful in paying good interest or dividends.

The average cost of duplication in the 10 public companies is $4.44, and without Fredericksburg is $4.09. The average cost in the case of the only three cities whose size makes comparison with the private companies fair, Philadelphia, Richmond and Wheeling, is $3.05.

In Table V. are given the gross profits in cents per thousand feet, and the allowance that perhaps should be made for interest and taxes. None save Fredericksburg pay taxes, while Richmond, Alexandria, Henderson, Wheeling, Bellefontaine and Charlottesville have extinguished their debt from their net earnings. While Philadelphia still has a small debt beyond the sinking fund, both Philadelphia and Danville have returned to the city more value by far than the debt. The price of gas, the percentage on the cost of duplication and the profit, both with the

interest and without, and the monopoly profit, after deducting taxes, are given.

Interest is reckoned in every case at 5 per cent., although some of the cities borrow for less. The price of gas was reduced in February, 1892, in Richmond and Danville, to $1.25.

It is often asserted that city management of a natural monopoly like gas works is undemocratic. Yet we have seen that in one of the most democratic States of this Union, Virginia, a considerable proportion of the large cities do thus own their gas works. This, too, is done without any suspicion of uprooting thereby the industrial framework of society, and not only without increase, but, if the citizens of these places, as of those owning their gas works in other States, are to be believed, with a positive diminution of political corruption. As I have elsewhere written, "some argue against city ownership of gas works as leading to public ownership not only of street and steam railways, telegraphs and telephones, but of baker shops and factories. As well hold that no one should eat lest he eat too much! Expediency and the result of experience must determine how far to go. They seem to justify public ownership and management of gas works, water works and electric lights. The same would doubtless be true of the telegraph and the telephone.

A Few Remarks on the Possibilities of Incandescent Gas Lighting.

[Communicated by Mr. H. Leicester Greville, F.I.C., to the *Journal of Gas Lighting*]

The *Journal* of December 6 contained a short notice* of some recent improvements in the Welsbach incandescent gas light, which are pregnant with interest as opening wide possibilities in this particular method of lighting. I am assuming that the statements put forward as to the extent of the improvements recently effected in the Welsbach system are true; but even making a large allowance for possible exaggeration, the question is of sufficient importance to justify more than a passing notice. It is claimed that the Welsbach burner of the future, while having a "mantle" of much greater duration than its predecessor—and therefore giving greater economy and less trouble with regard to this detail—will, in addition, afford a light of 19 candles per cubic foot of gas. This result, if true, would be unprecedented, and its full import can only be grasped by comparison.

The best regenerative burners of the most expensive type do not develop anything approaching this proportion of light to gas consumed; and they have the disadvantage, in most cases, of being less efficient on a small than on a larger scale, and also of requiring accurate adjustment of gas supply to develop their full capacity. All these considerations have much restricted their application, which has been limited mainly to larger lighting effects—private house lighting being mostly obtained by various burners of the ordinary types. The incandescent system has from the first had the advantage of possibly reaching the private consumer, by reason of the comparatively low price of the burner proportionately to the light development per cubic foot of gas consumed. That the system has not been more widely adopted must be attributed to the fragility of the mantles and the necessity of their periodical renewal, and also to the inability of the average consumer to realize the fact that it is false economy in the end to buy burners at the lowest possible price, in place of paying more for a better article. Anything will do to burn gas, and if the light is inferior, it is the gas which is blamed, whereas it should be in many cases the inefficient appliance provided for light development. How many consumers realize that a penny gas burner may afford a light of less than two candles per cubic foot, while the best class of light developers may afford five or six times as much, and, if recent statements be true, even a higher proportion? How many consumers ever take the trouble to balance increased value to be obtained from the gas against interest on capital expenditure at, say, 5 per cent.? A very simple calculation will show that, in cases where a reasonable amount of gas is consumed per annum, 1d. capital expenditure and 2 candles per cubic foot is infinitely more expensive than £5 capital expenditure and 10 candles per cubic foot.

Turning more especially to the incandescent system of gas lighting, one particular feature about it which has always impressed me is the fact that (with proper appliances—such as mantle, burner, etc.) the light development is purely a function of heat. When once this fact is thoroughly realized, the future possibilities of the system offer a wide field for speculation. Moreover, the proportion of light-giving hydrocarbons in 16 candle gas is comparatively small, and does not seriously influence its heating value. As a proof of this, I made the following experiments some years back with the old type of the Welsbach incandescent burner. An experimental holder was charged with gas, which, tested in the ordinary way, with the standard Sugg "London" argand, at 5 feet, gave 17.3 candles illuminating power. The gas was tested in the Welsbach, and the result noted. The illuminating power was then reduced by passing the gas through a small scrubber, charged with coke soaked in colza oil, to absorb a portion of the luminous hydrocarbons; and tests were again made by the "London" argand and the Welsbach. The following results were obtained:

Experiment No. 1.

	Sugg "London" Argand.	Welsbach at 2.3 Cu. Ft. Calculated to 5 "
Original gas	17.3	28.2
Treated gas	5.7	28.3

Experiment No. 2.

	Sugg "London" Argand.	Welsbach at 2 Cu. Ft. Calculated to 5 "
Original gas	17.4	35.2
Treated gas	7.2	35.2

We see, therefore, that the abstraction of a large proportion of the luminous hydrocarbons from coal gas does not affect its value as a light developer in burners on the incandescent system; and consequently poor illuminating gas is practically of equal value to a richer material. Of course, it must be understood that this remark would not apply to a gas whose poorness was due to any alteration of composition which would seriously alter its heating value.

Turning to practical considerations of the above results, it is well known that a comparatively large item in the cost of producing ordinary coal gas is the necessity of maintaining a sufficient proportion of illuminating hydrocarbons to afford the light required to meet the statutory obligations imposed on the various companies. The coal employed for gas manufacture may give as low as 12 or 14 candle gas, as tested in the usual way; but this has, as a rule, to be brought up to a higher standard by the use of cannel or oil, which forms a comparatively expensive item in manufacture. Further, the mere fact of the gas having to be manufactured at a higher lighting value than is normally realized in practical carbonizing from the bulk of the coals employed, leads in many cases to a tendency on the part of the management not to push the extraction of the gas from the coals to its full limits, as the illuminating value would correspondingly suffer. A proportionately large quantity of more expensive materials has then to be used, to bring the gas up to the statutory lighting power required. So long as gas is consumed in burners in which the luminosity is due to the presence of light-giving hydrocarbons, this state of things must be perpetuated.

It has been already pointed out that the proportion of hydrocarbons in coal gas to which the light is mainly due is comparatively small; and the proportion in which they increase the heating efficiency is even smaller. At the same time, while gas is perhaps likely to suffer from its rival electricity in the domain of lighting, it has a large and increasing sphere in the domain of heating—both for cooking purposes, for the development of mechanical power in gas engines, and for domestic fires. For all these latter purposes, gas could be supplied at a considerably cheaper rate than at the present charges, if it were not for the statutory obligation to have sufficient illuminating hydrocarbons present to supply a specific amount of light when tested in the orthodox way. Gas companies are, in fact, somewhat comparable to water companies in this detail. Both are vetoed on the ground of capital expenditure from employing a dual system of mains; and yet both have to supply to the public a material of a higher standard than is necessary for all requirements. Water companies have to produce an article up to a standard for drinking purposes, when a large proportion of the supply is devoted to flushing sewers and domestic drains, watering streets, and extinguishing fires; and gas companies have to comply with a standard of light, when an increasing proportion of their manufacture is being used for the development of heat and motive power. In the interests of the general public, all this is at present necessary; and it is simply mentioned in order to point the more forcibly what economies, in the question of gas supply, might be effected if future discoveries could give the necessary developments.

The discovery of a system of light production from gas as a pure fraction of heat, and comparatively independent of the presence of luminous hydrocarbons, is now an accomplished fact; and that the system is capable of development had also been recently illustrated. It is not, therefore, unreasonable to anticipate further improvements. The invention of some modified form of burner, which, while maintaining its illuminating efficiency, would stand a fair amount of rough usage with

* See Am. Gas Light Journal, Jan. 2, p. 7.

impunity, and which was, moreover, produced at a price well within the purchasing power of the average consumer, would make it possible to have almost a practical revolution in gas lighting. Pure heating gas could then be supplied at a considerably cheaper rate than has now to be charged for luminous gas. Such gas would have a far greater employment for heating and motive power, and light would be developed where required more economically than by the ordinary burners at present in use. The gas manufacture of the future might therefore be, without entering into minute details: (1) The carbonization of the coal to its extreme limits of gas production; (2) the extraction of the benzol as a bye-product, by the passage of the gas through heavy mineral oils, and subsequent distillation; (3) the production of water gas from the coke, to subsequently mix with the gas from the coal; and (4) the utilization of the producer gas, formed during the intervals of "blowing up" the coke to incandescence, to heat retorts and raise steam for general motive power.

The Present Status of Natural Gas in Ohio.

[The first of a series of articles prepared by PROF. EDWARD ORTON for the *American Manufacturer*.]

Though the subject of natural gas can hardly be said to have been a burning question in Ohio for the last few weeks, still it has occupied a good deal of attention in several districts of the State, and considerable progress has been made in these districts in learning its true character and value. It is obviously a good time in which to review the situation. The brief history of the experience of Ohio towns in this line for the last five years is replete with instruction, but the lessons may come too late for the service of the towns themselves. For communities, however, that have yet to discover large and available supplies of this best of fuels, the facts will prove of the greatest value.

In an article in the December *Forum* by President Elliot, of Harvard, the shortcomings of popular education are discussed in rather a discouraging tone. The author complains that after two generations of our people have been educated at great cost by the State, it cannot be shown that either the intelligence or morality of the community has been correspondingly advanced thereby. He seeks to show that sophistry, superstition, and the narrowest selfishness have as effective a part in forming the judgments of man as they ever had. Whatever our opinions may be on the instances cited by the author, if he had taken the facts pertaining to the treatment that natural gas has received in this country during the last ten years, he could certainly have based upon them a powerful arraignment of the intelligence, if not the morality, of those communities that have destroyed in a decade the fuel supply that should have been made to last for a half century. In the reckless waste and the wholly unwarrantable use of wealth in one of its most valuable forms, the communities that have had to do with natural gas in this period have so far outdone the barbarians that sacked Rome in the fourth century, that the latter are made respectable in comparison. Those that come after us may well replace the word "vandalism" in their vocabularies by some term derived from our recent experience. We all know how this waste has come about, and, deplore it as we must, we see that it was inevitable under the conditions of gross ignorance and selfish greed that dominate even what we call enlightened communities in these closing years of the nineteenth century.

In the present paper I will briefly review the gas rocks and gas fields of Ohio, and will sketch with equal brevity the history of each to the present time.

The Gas Rocks of Ohio.—There are four distinct geological formations that are at the present time supplying more or less gas to the people of Ohio for fuel and light. Named in descending order, they are as follows:

The Berea grit.
The Ohio shale.
The Clinton group.
The Trenton limestone.

The second formation of the list differs in important respects from the rest, and will be considered first.

The Ohio Shale as a Source of Gas.—Cropping out on the shore of Lake Erie, and extending westward from the Pennsylvania line as far as the mouth of the Huron river, and passing southward from this point to the Ohio Valley, which it reaches in the vicinity of Portsmouth, with an average breadth of 10 to 15 miles, a series of beds of shale, black, blue, or gray in color, constitutes the surface rock. The formation has been known to be a source of petroleum and gas ever since it has been occupied by man. Weak outflows of gas or oil occur all along the line, and have been noted alike by the uncivilized and the civilized occupants of the region. Natural gas was first turned to useful account in this country in 1821, at Fredonia, N. Y., the gas being derived from springs that issue from this shale formation.

Along the shore of Lake Erie, in the belt just described, there are scores, and probably hundreds, of shale gas wells. These are found in every township of the State on the lake shore within the limits named. The wells are shallow, rarely exceeding 300 or 400 feet in depth. It costs but little to drill a well, and the gas flow is in many instances kept up with remarkable persistency. A well will yield a few hundred or a few thousand feet of gas a day, and will sometimes maintain its production for a score or more of years. A single well will often supply the needs of a household. The pressure of the gas is low, seldom rising to, and rarely exceeding, 30 or 40 pounds to the inch. The use of this shale gas is essentially private use. All schemes for undertaking a public or manufacturing supply from this source have failed, and must necessarily fail. Considerable comfort and service, however, are derived from the gas of the Ohio shale at the present time in the ways indicated above. The facts pertaining to the shale gas remain unchanged from year to year. What is true to day was true of it 50 years ago and will be true 50 years hence.

The remaining gas rocks of the State belong in a very different category. They all hold high pressure gas and furnish it in quantity enough to encourage and support public and manufacturing supplies.

The Berea Grit as a Source of Gas.—This formation, in its outcrop of Berea, Amherst, Elyria, and many other points in northern Ohio, is a stratum of great economic interest and value, furnishing as it does the finest building stone and grindstones of the country. The annual production of the quaries established on it exceeds $1,000,000 in value. As the stratum dips slowly to the southward and eastward it becomes a repository of gas, oil and salt water, the gas and oil being obviously derived by slow percolation from the shale formation previously described, which directly underlies the sandstone. The Berea grit has wonderful persistence, as it is followed by the records of deep wells, below the surface. When it has descended far enough to take 800 feet or more of cover, it becomes, under proper conditions of structure, a reservoir of high pressure gas and flowing oil wells.

To provide an effective separation of the salt water, oil and gas, which the stratum always contains, it is necessary that the rock series should be traversed by low folds, arches or terraces. Such structure is occasionally found in Ohio from about the line of the Baltimore and Ohio Railway, southward and eastward from the Muskingum Valley, including, also, Harrison, Jefferson and Columbiana counties in part. Cambridge, Guernsey county; Cadiz, Harrison county; Barnesville, Belmont county; Macksburg, Noble county; Marietta, Washington county; Brilliant, Jefferson county; East Liverpool, Columbiana county, are points located on or in the vicinity of these low arches, and all of these localities are or have been centers of more or less production of high pressure gas. Several of these towns have undertaken the utilization of this gas for domestic fuel or for manufactures. Cambridge, Barnesville, East Liverpool, and Marietta may be named in this list, but only the last-named town has an effective supply at the present time.

A good deal of money has been expended in seeking a fuel supply for Cambridge from the source above named. Wells have been drilled by the dozen. The town has been piped by two companies, a home company, which has pursued a cautious and conservative policy, and which without any large outlay has furnished the unspeakable luxury of gaseous fuel to a small part of the population; and a company principally composed of Eastern capitalists that has made large and, as the event has proved, unprofitable investments. The wells of the home company are not more than 1½ miles from the town. The wells of the other company are 8 or 10 miles distant. Both of the companies suffer more or less trouble from the invasion of salt water and oil.

From these two corporations a fraction of the population of Cambridge enjoys a somewhat inadequate supply of fuel for 9 or 10 months of the year. During the winter months it becomes necessary to reinforce the gas by the grosser forms of fuel, and more or less discomfort and exposure are entailed on the people in making the transition. Uncertain and deficient as is the supply, it is highly valued.

Barnesville likewise has a home supply of gas sufficient for a small part of its population in mild weather, but entirely inadequate to cope with the temperatures of the present winter. The supply is derived from wells about two miles distant from the town, the average production of which does not exceed 150,000 cubic feet per day. The rock pressure is, however, fairly good, and whatever gas there is is sent promptly to its destination. The work has been carried on by a home company and with due economy.

Marietta has a much more promising supply than the towns named above, derived from wells located on fairly developed arches within a few miles of the town. The original daily production of several of the wells reached into millions of feet and the initial rock pressure was reported at 700 pounds. I have heard no complaint from this town during the last month and therefore conclude that the supply has been fairly maintained.

The new oil fields opposite Sistersville, W. Va., furnish gas to a few families in Monroe county.

Bellaire, Steubenville, Wellsville, Toronto, East Liverpool and other smaller towns in the Ohio Valley have been dependent on gas derived from the Berea grit, but mainly brought into the State from wells located on the east side of the Ohio river in West Virginia and Pennsylvania. These towns have had a capricious and generally inadequate supply almost from the beginning. Even in moderate weather the service in them has been latterly unsatisfactory; but when it comes to winter weather like that of the present year, the failure is so pronounced that reinforcement of fuel from the coal banks becomes imperative. In spite of the urgent need of gas for domestic use by thousands of families, a few manufactories established in the district have managed to maintain a dying life on gas drawn from the same fields that supply the towns. Such use of gas is so miserably selfish and regardless of the general good that it can find no defense in equity. Such consumers probably justify their course on the ground that somebody is sure to abuse these gifts of nature in this way.

The Conductivity of Insulating Bodies.

The effect of the physical condition of substances upon their dielectric properties is one that is deserving of more study than it seems to have received. In the *Philosophical Magazine* M. Edward Branley, M.D., calls attention to the fact that very thin fibers of insulating bodies seem to become conducting, and that good conducting material opposes great resistance to the passage of a current when inserted in its path in a pulverulent condition. Thus far there is nothing in his statements that might not have been arrived at by *a priori* reasoning; but that the conductivity of the pulverulent mass may be measurably restored by the discharge of a Leyden jar in the vicinity and destroyed again by a slight mechanical shock, while not new, could scarcely have been anticipated by theory. The phenomena having been demonstrated, however, one or two theories at once suggest themselves as plausible explanations of their cause. There are one or two other phenomena of thin fibers or pulverulent dielectrics, however, whose explanation is not so obvious. For instance, if the two ends of a circuit be varnished with shellac, and after the latter is thoroughly dry be brought into intimate contact, the insulation against low potentials is practically perfect. But place this junction in an atmosphere of pure hydrogen gas, the resistance is gradually lowered until comparatively good conductivity is established, only to be destroyed again equally gradually when the hydrogen is removed.

Neither mechanical shocks nor moderate increase of temperature seem to have any perceptible effect upon the rise or subsidence of conductivity. But if the treatment with hydrogen be repeated after complete resumption of the insulating state in air, the junction cannot be restored to the same degree of conductivity it was made to assume in the first instance, and the effect of the hydrogen gradually decreases with each subsequent application, until it seems to disappear entirely. Carbonic oxide and artificial marsh gas produce the same effect, though to less degree, while natural marsh gas seems to be inert. The presence of carbonic acid, nitrogen, oxygen or other electro-negative gases, even in considerable proportion with the hydrogen, seem to have no effect upon the phenomena except what might be reasonably attributable to the dilution caused by their presence. On the other hand, if finely-pulverized hard glass be imbedded in the two ends of the circuit and they be brought together again as before, and hydrogen applied, a much higher conductivity will be attained than in the case where shellac was the dielectric, but it will not be assumed gradually as before, but in a series of impulses each succeeded by a non-conducting state, these electric impulses becoming more and more frequent until the current finally passes continuously with nearly the same freedom as it would were the conductor unbroken. On removing the hydrogen, the junction remains conducting much longer than where shellac is used, but loses its conductivity completely and instantaneously. Thus many substances have been tried with similar results, but differing in degree. But the manner of assuming conductivity and of losing it again seems to differ with each, and to be in a measure characteristic of the substance employed. A satisfactory explanation of these phenomena has not yet been suggested.

Electricity in a Small Arms Factory.

M.M. L. Castermans and F. Melotte have compiled the following particulars relating to the electric motor equipment of a small arms factory at Liege, Belgium:

In 1886 several of the gun-making firms in Liege formed a syndicate for the erection of a small arms factory upon the most improved principles; and upon receiving an order for 150,000 to 200,000 Mauser rifles, 6.75 mm. caliber, from the Belgian Government, a company called the National Military Arms Factory was organized for carrying out the scheme. The factory, designed by Mr. Castermans, is placed entirely on the ground level, avoiding the use of upper floors, the larger portion of the machine tools being contained in a large hall about 345 feet long and 245 feet broad, placed at some distance from the forges and the engine and boiler houses, in order that their working may not be influenced by shocks or dust. The more dangerous shops in which wood working is carried on are also placed on the outside, so as to be readily accessible in case of fire. The site selected, of about 20 acres, is at Herstal, which necessitates the use of pumping machinery to bring feed water from the lateral Meuse Canal, at a distance of about one-half mile—an inconvenience which is, however, counterbalanced by having skilled workmen close at hand, the locality being in the center of the gun trade.

The area of the covered buildings is 22,000 sq. m. They were completed in six months.

The main shop is divided into 14 bays by lines of columns spaced 7½ m. apart, each being of sufficient width to take four rows of machines with a passage between them. The roof lights are glazed with large sheets of plate glass, which dispense with the ordinary heavy iron sashes, besides diminishing the chance of breakage. A proof house, with a sighting range of 200 m., adjoins the factory on one side.

The chief point of interest is, however, to be found in the arrangement of the driving power and transmissions. For the actual work of the machines 13 lines of shafting, varying in their demands from 12 to 30-horse power each, to a total of 200-horse power, are required; but in order to maintain the necessary subdivision from a single motor by the ordinary method of driving with leather belts or manilla ropes, about 70 tons of intermediate mechanism, 40 tons of shafting and pulleys, and 30 tons of bearings would be necessary. As an alternative, a telodynamic cable for carrying a large portion of the power by a single change was suggested, but was considered objectionable, the large driving pulleys, 14 feet in diameter, and the presence of a rope traveling at a very high speed through the shops, being likely to cause inconvenience.

It was ultimately decided, on the proposition of the Compagnie Internationale de l'Ectricite, to drive each of the separate lines of shafting in the shops by an electromotor receiving the current from a dynamo connected with the main engine, whose armature replaces the flywheel of the latter. In this manner a current of 2,440 amperes at 125 volts is produced by an armature of very large size, moving at the low speed of 66 revolutions per minute—a combination which has not hitherto been attempted, at any rate upon the same scale.

The power required being 200 horse power, the motors supplied and their guaranteed efficiencies are:

									Per Cent. of Efficiency.
9 of 12 H.P.	= 108 H.P.,	require	9	motors of	16 H.P.	= 144 H.P.			87
2 of 16 "	= 32 "	"	2	"	21 "	= 42 "			87
2 of 30 "	= 60 "	"	2	"	37 "	= 74 "			89
	200					260			

—which requires 165.5 + 48.3 + 83.1 = 296.9, or, allowing 2 per cent. for loss in the conductors, 303-horse power at the terminals of the dynamo. The efficiency of the latter being guaranteed at 90 per cent. of that of the engine, the available work demanded from the fly wheel shaft is 333.6-horse power, corresponding to a transmission of 77.2 per cent.

The horizontal compound condensing engine of 500-horse power is made by M. Van den Kerkhove, who guaranteed the internal resistance not to exceed 8 per cent., or 40-horse power, but it has been found to be something less than 6 per cent., allowing for which the final result comes out as 72.5 per cent. of the indicated horse power available at the driving pulleys of the motor dynamos. The main dynamo is of the gramme type of construction, that system of winding being called for by the large dimensions of the armature.

About 110-horse power is taken off the main current for the electric lighting, which includes 116 arc lights of 10 amperes, arranged two by two in series, and 200 16 candle incandescent lights. The latter are

supplied from a ring with 24 feeders, which are not covered except in the tunnel between the engine room and the distributing board. The drop in the current is 7 volts when the whole of the lamps are lighted.

The motors distributed through the works are all of the same kind, with a double magnetic circuit and gramme armatures. The magnet cores are cylinders of wrought iron, placed upright, with cast iron pole pieces, which are fitted to the framing and bored out at the same time as the shaft bearings in order to have the armature perfectly centered. The armature core is formed of disks of sheet iron carried upon a series of arms parallel to the shaft attached to a boss cast in bronze. The winding has only a single outer layer of wire. The ends of the commutator plates are contained in a hollow cone of cast iron, which is secured by a conical ring, the whole forming a perfectly compact mass which cannot be distorted even by the blow of a hammer. The brushes are made of a special kind of carbon, which gives no trouble even under considerable variations in load, so that the electrician in charge has only to attend to the starting and stopping, the greater part of his time being occupied with clearing and replacing the carbons of the arc lights, which, as before stated, are 116 in number, distributed over an area of about 11 acres.

The number and distribution of the motors in use is as follows:

Position.	H. P.	Number.	Guaranteed Efficiency.
Great hall	16	9	87 per cent.
Wood-working shop	21	1	87 "
Forges	37	2	89 "
Breech-action shop.	16	1	87 "
Polishing shop	16	1	84 "
Pumps	10	1	85 "
Ventilator	3	1	80 "
Cartridge shop	21	1	—

The average efficiency of the motors is 87 per cent., which, multiplied by 98 per cent. for that of the conductors and 90 per cent. for the principal dynamo, gives 76.6 per cent. as the efficiency of the transmission—that is, the relation between the steam power and that delivered to the shop shafts. The total weight of copper in the distributing circuit is 5.4 tons.

In the electrical transmission the resistances producing losses are made up of those of the magnetic core, which are substantially constant, and those of the armature wire and the armature bearings and conductors which, according to Joule's law, are proportional to the resistance of the conductors and to the square of the intensity of the current; while in the former the losses in transmission are constant whatever may be the proportion of power utilized, so that this method becomes very disadvantageous when the power is not fully employed. This is shown in the following table, where the losses are supposed to be the same on both systems under full load, which is putting it rather too favorably for the mechanical system.

Electric Transmission.

Power charged	1,000	750	500	333	250	200
Fixed loss	50	50	50	50	50	50
Variable losses	50	27	11	4.5	2.2	1.2
Disposable energy of dynamo	900	673	439	278.5	197.8	148.8
Efficiency, per ct.	90	89.7	87.8	83.5	79.1	74.4
Loss in conductors, variable	18	10	4	1.7	0.8	0.5
Disposable at motor	882	663	435	276.8	197	148.3
Fixed losses, 6 per cent.	53	53	53	53	53	53.0
Variable losses, 4 per cent.	35	20	8.5	3.4	1.7	1.0
Disposable energy.	794	590	373.5	220.4	142.3	94.5
Final efficiency, per cent.	79.4	78.7	74.7	66.2	57.0	47.2

Mechanical Transmission.

Power charged	1,000	750	500	333	250	200
Fixed losses	206	206	206	206	206	206
Useful work	794	544	294	127	44	—
Final efficiency, per cent.	79.4	72.5	58.8	38.1	17.6	—

From which it appears that with the motor at half power and below the loss in transmission is very much larger by mechanical than by electrical means.

A series of determinations were made of the average power required by different groups of machines and the loss on the intermediate transmissions. This was done by interposing in the circuit of a motor driving a principal line of shafting a registering ampere meter, giving a curve of which the abscissæ are proportional to the time and the ordinates to the intensity of the current. As the latter bears a certain ratio to the energy absorbed by the motor, it is easy to compute from the curve the work done at any particular moment when the voltage and proportional effect are known, and the measuring apparatus used in this way becomes a most perfect dynamometer. The method has been applied to determining, 1, the work absorbed by different machine tools; 2, the requirements of the different shops under ordinary working conditions, and 3, the coefficient of friction of the different lines of shafting. Several of the diagrams published in connection with the original paper show the demand on the engines to be extremely irregular and to vary very rapidly; but as a rule not more than 50 to 60 per cent. of the total power is required with the shop in full work. In the first bay of the great hall, containing the most exact tools employed on the production of cutters and drills, when very actively employed, the average power taken was 7.3-horse power during several hours observation, with a maximum of 11-horse power for a few moments when several heavy machines were put in gear simultaneously. During the remainder of the time the power varied from 8½ to 6-horse power and sometimes fell to 5-horse power. When all the machines were thrown into gear with their cutting tools lifted the meter registered 11-horse power and the shafting alone running empty 4-horse power, or 55 per cent. of the 7.3-horse power required under normal working conditions.

In a similar experiment made at the Royal Arsenal at Liege, a group of machines required 6.2 horse power when doing no work, which was raised to 6.9 horse power when the cutting tools were made to bite. When all the machines were thrown off 4.2-horse power was registered, showing that 2 horse power was required by the tools (shaping machines and lathes) when running light, and only 0.7 horse power more when doing work. The proportion of the latter is 26 per cent. of the work supplied to the machines as 1.25 per cent. of that of the powerful shaft. The results indicate very clearly how small a fraction of the power supplied to machine shops is actually utilized and the profits to be looked for in improving methods of transmission.

Transmitting Strength of Shafting

It is generally pretty well known, says the *Scientific Machinist*, that a shaft will transmit power in proportion to its running velocity and therefore the faster a shaft runs the lighter it should be within reasonable limit. The use of extremely heavy shafting is not advisable under any circumstances, unless actually needed to perform the work required. Some imagine, says the *Mechanical News*, that a large shaft affording a very strong margin of safety, is the most economical to use; that, however, cannot be considered a logical and tenable mechanical position, unless tempered with sound judgment and much wisdom, sufficient of both to select properly. That there should be an ample margin of strength no one will attempt to deny, but shafting multiplies in strength so rapidly as sizes increase, that the unenlightened are apt to make the selections much too large when aiming at only ample strength margin. To show how easily uninformed mechanics may make mistakes of that kind, it is only necessary to say that a three-inch shaft has nearly three and a half times the transmitting strength of a two-inch shaft. None unaware of the fact would ever guess at that difference and may fall into the error of selecting a three-inch shaft to safely do the work of a two-inch. To more favorably illustrate the difference, it can be stated that a two-inch shaft, properly sustained with bearings at reasonable intervals, will safely transmit 20 horse power at 100 revolutions per minute and at the same time resent the transverse strain due to weight of pulleys and the pull of belts necessary for transmitting that much power. Under like circumstances and equally proportionate conditions, a three-inch shaft will just as safely transmit 68 horse power at 100 revolutions per minute. Shafting should never be so large as to make it absolutely rigid; on the contrary, it should be to a fair degree elastic, with an ability to give and take between the power and the work. When too rigid, unless away above all requirements in size and strength, the liability to break is increased, especially if the work is of an abrupt and severe character. Long lines of shafting, having the power at one end and the work at the other, should be graduated in size; the work end being of a size required to safely do the work and the power end larger, in proportion to the length of the shaft or the distance beeween power and work. If such shafts be of the same size the entire length, and that a fair working size only, there will be too much elasticity in the aggregate, which will tend to gradually weaken, distort, and, in the end, destroy the usefulness of the shaft.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. JAMES R. SMEDBERG, writing to the JOURNAL, under the caption of "Things Nitrogenous and Otherwise," says: Mr. Egner's recent letter* regarding the Harris heresy is most capital reading for any gas maker who likes a little nonsense now and then; and I, for one, thank him for the sufficing pile driver with which Frederic has extirpated a hitherto mordacious specimen of the fly tribe. An opulent laity, however, may yet have cause to regret that the charming satire was not couched in more popular phrase, showing forth the financial damnation of that arch-fiend, nitrogen, whose comet-like return compels a wider distribution of wealth than any presidential election at all. In spite of the proverbial squirms and divagations of inventors, most of them have accepted as a fact that it is a sulky and bulky handicap. Its characteristic annihilation of flame temperatures and illuminating values has been utilized by Farmer and Erdmann, in different but scientific ways, for the valuation of gases too rich for the bailiwick of the Bunsen photometer; and two of its alliances—one with carbon and hydrogen to form cyanogen, and the other with hydrogen alone to form ammonia—govern Fogarty's brilliant metamorphoses. From the high level of thought, candor and logic occupied by men like these, the descent to a peerless folly is an abysmal and diabolical gravitation, well worthy of the term "process" in its worst and most frequent sense. The accepted laws of mensuration, combustion and photometry are decapitated by Mr. Harris's trenchant epigrams. At the touch of his unique magic a sphere becomes a "regenerative ball," affording more surface per cubic inch of content than any ineffectual platoon of mere prisms and cylinder and other shapes, be they dodecahedral or amorphous. Galvanilike, he punctuates a gaseous corpse, and straightway the goddess *Nitrogen* burns and glows and promotes the heat and radiance of carbon and acetylene. His absurdities are peerless, as has already been said; and if they were not mischievous, might be left in silence to early and inevitable suicide. * * * * Speaking of inventors, one of them submitted the other day, to an engineer, who is a very good friend of mine, the following process, which will, when perfected, disable carbon entirely: First, an air chamber is to be surrounded by a water jacket; second, the air in the chamber is to be compressed by a hand pump to a very high tension; third, the air compressed must surrender heat to the water in the jacket; fourth, hot water generates steam, as culinary professors are aware; fifth, steam may be used to drive motors, the inventor asserts; sixth—*operation:* The steam so obtained drives any desired number of machines, a small percentage of it being diverted to displace the hand power necessary at first. The pump compresses the air, the air heats the water, the hot water yields steam, and so on *ad infinitum*. Theoretically, the work of the pump need not be constant; but it must not be forgotten that there will be a very slight but unavoidable loss by radiation which must be made good by reiterated pumping. * * * * Dismissing both inventors to the Limbo awaiting nitrogeneous and hydro-pneumatic offenders, it may be observed that a genius named Loveless once took out a patent in which he claimed the employment of a water jacketed carbureter "for the purpose of keeping the gasoline cool during the progress of evaporation." I have sufficient reason to remember this new discovery; for I once, while a witness in a San Francisco court, explained the refrigerating effect of evaporation, and shall carry to my grave the marks of a neat decortication by the loveless counsel for the other side. A juryman afterward told me that my ignorance of physics had lost the case. * * * * Abundant instances exist in patent literature of wasted energies and vain imaginings, and I may quote additional ones in a future note.—Very truly, JAMES R. SMEDBERG.

THE Selma (Cal.) works—a small oil gas plant—have been closed down to permit of necssary repairs. The stoppage will last, perhaps a month, and the consumers might be forgiven for saying a word or two in disparagement of the management, who, in their notice of the cessation of gas making, explain the stoppage rather nakedly, or about like this: "Some of the machinery has been out of order for a *long time*, and *now demands* attention."

The authorities of Newark, N. J., and the local Gas Companies are about to enter into a revised contract for the public lighting of that city.

THE contract for the improvements on the government gas works of the West Point (N. Y.) Military Academy has been awarded to J. J. Kennedy, of Linwood, Pa.

* See JOURNAL, Jan. 30 148

"H.," WRITING to the JOURNAL, from Wisconsin, under date of February 2d, makes the following inquiry, any replies to which we will be pleased to publish:

To the Editor AMERICAN GAS LIGHT JOURNAL: Will some one having had a similar experience please answer. The top of a small, old gasholder (with building over it) leaks at the seams. Has been caulked from time to time, but as the iron is light, prefer not to caulk any more. Would rather not tear it out and build now until next March, or the following spring. Question—can anything be done, in the way of cloth, paper or other material on top of holder, to stop the leaks? If so, what; and how applied?

"J. A.," WRITING to us from Lima, O., under date of the 3d inst., says: "The Greensburg (Pa.) fuel gas plant was burned on January 20 last. This plant, which was only completed on January 1st, was being run 30 days to test its efficiency, when the fire occurred. Greensburg was one of the many Pennsylvania towns that seemed to have an inexhaustible supply of natural gas, but in the last two years the supply at Greensburg failed entirely. The destroyed fuel gas plant was constructed for the purpose of furnishing an artificial fuel gas, to be piped through the natural gas mains and burned under the same conditions that the natural gas was. The capacity of the machine was 1,000,000 cubic feet per day, and, at the time of the fire, was supplying fuel to 1,200 stoves and grates. The Greensburg Gas Company, however, at once decided to rebuild, and has contracted with Mr. Joseph Askins to construct a plant rated to manufacture 1,500,000 cubic feet per diem; also, to put in a set of purifying boxes 20 feet square. The work is to be begun at once, and pushed to a rapid completion."

THE Harris process manipulators say that they will construct an opposition works at Ann Arbor, Mich., and they may count on a particularly warm reception at the hands of Mr. Henry W. Douglas and his associates of the present Ann Arbor Gas Light Company.

THE following matter from a recent special message of Mayor Matthews, of Boston, to the Common Council, explains itself: "I took occasion in my inaugural address to refer to the exorbitant prices charged for street lighting by the different gas and electric light companies now engaged in that work, and recommended that the appropriation for the ensuing year be fixed at $545,245, a substantial reduction from the estimates based upon the prices now paid. The Committee on Appropriations having adopted this figure, and the same having been voted by the Board of Aldermen, it seems safe to assume that this will be the total amount available for street lighting purposes during the year. The corporations interested having shown no disposition to reduce the present exorbitant rates, and the city being to a great extent hampered by the laws of the Commonwealth in its dealings with the corporations, and thus prevented from obtaining gas and electricity for the purpose of lighting its streets, parks and public buildings at reasonable prices, I have felt it my duty to petition the Legislature for redress. The petition read as follows: To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled: Respectfully represents Nathan Matthews, Jr., Mayor of the city of Boston, that the said city is now paying for the lighting of its streets, parks and public buildings very much more than any other large city in the country; that it has no right to charge annual fees or rent for the use of the streets by private corporations manufacturing gas and electricity; that it has no right to collect reasonable compensation for the injury to the surface of its public streets by the excavations of said corporations made therein for the purpose of laying and repairing their pipes and wires; that it has no right to collect taxes upon a large part of the capital invested in said corporations; that it has been deprived by Chapter 370 of the Acts of 1891 of the right to light its own streets, parks and public buildings; and that by this and other statutes of the Commonwealth it is prevented from procuring gas and electricity for lighting its streets, parks and public buildings at reasonable prices. Wherefore your petitioner prays for the enactment of such legislation as will permit the said city to manufacture or purchase gas or electric lights for its streets, parks and public buildings at fair and reasonable prices, and particularly for the enactment of the following measures: *First.*—A law authorizing the Board of Aldermen of said city to prescribe the payment of certain annual fees as a condition upon which all locations in the streets of said city, heretofore or hereafter granted, shall be used and enjoyed. *Second.*—An act compelling all gas and electric light companies doing business in said city to pay the said city a tax at the general rate for the year upon the amount of notes, bonds, or other obligations owing by said corporation and not specifically returned to any

local board of assessors in the commonwealth. *Third.*—An act compelling every gas and electric light company doing business in the said city to furnish gas and electricity to said city for lighting its streets and public buildings at the reasonable cost to manufacture the same, the said reasonable cost to be determined by the Board of Gas Commissioners, upon application by the Mayor of said city. *Fourth.*—An act authorizing the City Council of said city to prescribe by ordinance a sum which shall be paid by individuals and corporations receiving authority to open the streets of said city for laying pipes and wires or making repairs, said charge to be a sum in gross for each excavation, or a sum proportionate to the length of excavation. *Fifth.*—An act repealing so much of Chapter 370, of the acts of the year 1891, as prohibits said city from making gas and electricity for lighting its streets, parks and public buildings. *Sixth.*—An act amending Chapter 350 of the acts of the year 1888, so that application to the Board of Gas Commissioners for the revision of rates or contracts may be made by the said city as well as by the gas companies. *Seventh.*—Laws applying the foregoing principles to all cities and towns within the commonwealth. I have been convinced for some time that the city was paying more than it should for lighting its streets. It not only costs more to light the streets of Boston than those of any other large city in the country, but the city is prevented by law from securing a return from the corporations using the streets for commercial purposes. Until the year 1891 the city had at least the opportunity to establish a plant for lighting the streets at public cost; but this right was for some unexplained reason taken away by the Legislature of that year. Public attention was not drawn to this feature of the municipal lighting bill of 1891 (Chapter 370), and I can see no reason why this restriction should not be immediately repealed. As to what should be paid by the city for this work, opinions may differ, but in a general way it would seem to be proper to demand of corporations, who have the use of the streets for nothing, that they should light those streets at a price little, if any, above the reasonable cost to manufacture. So far as gas is concerned, the special report of the Board of Gas and Electric Light Commissioners, made to the State Senate in 1892, shows that the cost of manufacturing gas by the large companies doing business in Boston is about 53 cents in the holder and 77 cents at the consumer's meter. The consumer, for the purpose of this calculation, is the average consumer, having a special and separate meter; and the cost of distributing gas to the city, a single consumer and the largest of all, must be less than the 77 cents found to be the cost at the general consumers' meter. With these facts in view, it must be obvious that the prices charged by the gas companies for street lamps, which vary from $1 to $1.50 per 1,000 cubic feet, are unquestionably excessive, and that the still higher prices charged to private consumers are also exorbitant. As to the actual cost of electric lighting there seems to be a wide difference of opinion and assertion. The companies interested have maintained that the cost of manufacturing 2,000 candle power lights was from 40 to 60 cents per night in this city, while on the other hand individuals have asserted before committees of the Legislature and elsewhere that such lights could be manufactured for less than 20 cents. The city is now paying $146 per year, or 40 cents a night." Mayor Matthews then follows with two sets of estimates, prepared respectively by the City Engineer and Messrs. Stone & Webster, showing what it would cost the city to construct an electric lighting plant, as also the cost of each 2,000 candle power arc lamp per night under the assumed conditions. Under the estimate of the City Engineer (who proposed the construction of two stations, rated to furnish 2,000 lamps and 3,000 lamps), the cost for each lamp per night would be 27.7 cents and 25.8 cents, respectively, whereas the estimate of Stone & Webster (who proposed the construction of a single station, rated to furnish 2,000 lamps and 3,000 lamps, respectively), the cost per night per lamp was returned at 36.6 cents and 29.2 cents; both estimates allowed 6 per cent. for interest and a like percentage for sinking fund. The Mayor then concludes: "These figures are instructive, and may, I think, be assumed to be conservative, as I have never known an underestimate of cost to proceed from the City Engineer's office. The widespread belief that too much is paid by the city as a corporation, as well as by its individual inhabitants, for gas and electric lights, would seem to be amply justified by the foregoing calculations; and it appears to be the duty of public officers to do what they can to procure more moderate and reasonable charges."

THE Directors of the Wilmington (Del.) Coal Gas Light Company have declared a dividend of 3 per cent., payable on demand.

WE regret to have to report the death of Mrs. F. H. Parker, wife of the Superintendent of the Burlington (Vt.) Gas Light Company. Her death occurred on Friday, February 3d, and the funeral services were held on the afternoon of Tuesday, Feb. 7th.

THE following notice, published at the instance of Mr. E. S. T. Kennedy, President of the Hazelton Boiler Company, of this city, explains itself:

"NEW YORK CITY, January, 1893.

"*To Manufacturers and Users of Steam Boilers:* Frequent inquiries make it proper for us to inform manufacturers of steam boilers and the steam using public that this Company is in no way responsible for the bad materials used in boilers of the Porcupine type, furnished by the Hazelton Tripod Boiler Company, of Chicago, which concern, without valid patents or manufacturing plant, has for the past 6 years been furnishing inferior imitations of our boiler in direct violation of our rights. This Tripod Company is now defunct, and its affairs in process of settlement by an assignee. This has no doubt resulted from its course of its business—inferior materials and workmanship not being appreciated by steam users. The failure of the Tripod Company naturally follows the failure of its boilers. To thinking men it will suggest the wisdom of dealing with Companies of established reputation, and whose boilers are unequaled in steam production, economy, durability, and safety. We are the true and rightful owner of the *Hazelton Boiler*, which is frequently called the *Porcupine Boiler*, and all of our boilers are constructed exclusively in our own manufacturing plant in this city, under our own patents and personal supervision, and only the highest grades of materials and most skilful workmanship are employed. We have 100,000 horse power of this boiler in successful operation in all the principal industries, and the good reputation of our boiler was long since established. We caution the public in general, and steam users and boiler manufacturers in particular, against imitations of our boiler. *Note carefully the difference in the names.* Respectfully yours, THE HAZELTON BOILER COMPANY, New York City, U. S. A."

THE following is the text of the bill brought before the Illinois Legislature at the instance of the body known as the Municipal Gas League:

An Act to enable cities and villages to construct and maintain gas works and electric works for municipal purposes and to supply private consumers.

First—Be it enacted by the people of the State of Illinois, represented in the General Assembly, that the city council of cities, or boards of trustees of villages, shall have power to provide for a supply of gas and electricity for municipal purposes and private consumers of light, heat and power by the construction and regulation of gas works and electric works, and to borrow money therefor; also, to prevent the unnecessary waste of gas and electricity and to prevent injustice to such works.

Second—For the purpose of establishing gas and electric works, any city or village may take and condemn all necessary lands and property therefor, in the manner provided for the taking or acquiring private property for public uses.

Third—The city council or board of trustees shall have power to make all needful rules and regulations concerning the use of gas and electricity supplied by the gas works or electric works of said city or village, and to do all acts and make such rules or regulations for the construction, completion and management and control of gas works and electric works and for the levying and collecting of any gas or electric taxes, rates or assessments, as the said city council or board of trustees may deem necessary and expedient. And the corporate authorities may levy a general tax for the construction and maintenance of such gas works and electric works, and appropriate money therefor.

AT the annual meeting of the Parkersburg (W. Va.) Gas Company the control passed out of the hands of Mr. C. S. Despard, who controlled its fortunes for many years. The following officers were chosen: Directors, Messrs. J. V. Rathbone, C. H. Shattuck, C. S. Despard, C. H. Turner and J. M. Jackson, Jr.; President, C. H. Shattuck; Vice-President, J. V. Rathbone; Secretary and Treasurer, J. M. Jackson, Jr.

CHEAP and nasty must be the little oil gas plant which the Southern Fuel and Gas Company has installed at Manchester, Va., under the franchise recently granted for the operation of a gas works there; for in less than six weeks from the obtaining of the consent the Company claims to have completed its manufacturing plant—and everybody knows the sort of weather that we have had this winter, as to its effect on or as a factor in influencing speed in building operations. It is true, though, the Company admits that much has yet to be done in the way of main laying.

CAPTAIN J. T. FOSTER, who was re-elected President of the Malden and Melrose (Mass.) Gas Light Company at its last annual meeting, is likely the oldest (in point of actual age) Gas Company President in the country. He was born February 5th, 1810.

A BLAZE in the purifying house of the water gas annex to the 25th ward works of the Philadelphia municipal gas plant occurred on the morning of the 4th inst. The damage amounted to perhaps $25,000, but the loss will fall on the insurance companies, as the property was fully protected. The plant is owned by the Philadelphia Gas Improvement Company, and will be restored at once.

THE following is the official announcement respecting the recent concession made by the Waltham (Mass.) Gas Light Company in the matter of gas rates: "The Directors of the Waltham Gas Light Company, at their meeting, Thursday, Jan. 19th, voted the price of gas, from Jan. 1st, 1893, be made $2 per 1,000, with 10 per cent. discount if the bills are paid on or before the 15th day of the month when bills are due; and for gas used in gas stoves an extra discount of 10 per cent., providing the consumer will pay the cost of connecting a meter for registering the gas."

WE understand that Mr. S. E. Kellogg, formerly in charge of the Fairfield (Ia.) Gas Company, has accepted the Superintendency of the works at Le Mars, Ia.

AT the annual meeting of the Ypsilanti (Mich.) Gas Company the following officers were chosen: Directors, Messrs. D. L. Quirk, C. S. Wortley, C. E. King and H. S. Dodge, and Miss Helen C. Swift; President, D. L. Quirk; Secretary, C. L. Wortley.

EDWARD THOMPSON, a Duluth (Minn.) photographer, has begun an action against the Duluth Gas and Water Company, because of injuries sustained by himself and wife last fall while driving on Fifth street, that city. He bases his complaint on the failure of the Company to properly guard an excavation that it had made in the streets, and alleges that such negligence resulted in the overturning of the vehicle in which his wife and he were travelling. He puts the damages at $2,000. The Company interposed a denial of the charge of negligence, and adds that defendant's recklessness was the cause of the overturning.

THE Norwich City (Conn.) Gas Company has ordered a decrease in the gas rate of 25 cents per 1,000 cubic feet, or from $2.25 to $2.

AT the annual meeting of the Westfield (Mass.) Gas Company the only change in the management was the naming of Superintendent W. T. Thayer to the Board of Directors—a well merited promotion.

IT is proposed to operate a Gas Company at Fairfield, Conn., the Legislature having been petitioned to charter a corporation, to be known as the Fairfield Gas and Water Company. This place is close to Bridgeport, and it is not unlikely that the Bridgeport gas men are interested in the new venture. Should such prove to be the case, all that would be needed at Fairfield to carry on a gas supply would be a storage station and the requisite mains. It looks to be a good gas field.

LATER advices respecting the proposed opposition gas company at Ann Arbor, Mich., are as follows: The Company, which is to be known as the Ann Arbor Fuel Gas Company, is capitalized in $100,000, and the projectors agree not to charge for gas at a rate in excess of 75 cents per 1,000 cubic feet. The officers are: President, Frederick Schmid; Vice-President, W. D. Harriman; Secretary and Treasurer, L. Gruner.

A RATE war has been commenced in the Carondelet district, at St. Louis, Mo. The local electric light company has been supplying current to lamps at very low figures, evidently with the hope of ultimately forcing the Carondelet Gas Company to sell out to its rival. The proprietors of the Gas Company, however, have determined to give the electricians measure for measure, as will be understood from the statement that the gas rate has been lowered to $1.25 per 1,000. It was $2.

THE Pekin (Ills.) Company for some time this winter was obliged to carbonize local coals, with the result that much complaint was made about the quality of the gas sent out.

Liquid Air.

Some weeks ago Professor Dewar lectured before the British Royal Institution on "Liquid Air," in the course of which he gave some of the results of his recent investigation of the properties of matter at very low temperatures. In his prefatory remarks the lecturer touched upon the difficulties of what he described as "pioneer work."

Liquid oxygen, until recently, was a curiosity produced in very small quantities, too small and too evanescent to admit of any exact and systematic examination of its properties. Professor Dewar, according to the *Times*, produces it by the pint, and demonstrated its more obvious physical properties—its beautiful color, the blue of the sky, its high magnetic quality and its characteristic spectrum—with as much facility as if he had been dealing with water. But all this, simple as it perhaps looked, has only recently become possible, and that through a very beautiful discovery of Professor Dewar's, possessing equal practical and speculative value. Liquid oxygen, boiling at 182° below zero, is at ordinary temperatures always in a state of violent ebullition, which, in the first place, means very rapid dissipation, and in the second interferes seriously, and for many purposes fatally, with the determination of its properties. The double problem, therefore, was to find some means of preventing the waste of a costly liquid and of obtaining it in a state of quiescence suitable for experiment. All the ordinary non-conducting devices proved useless, but the problem was solved by the discovery that by surrounding the vessel containing the liquid with a very high vacuum the influx of heat from outside could be reduced to one-seventh. The result is liquid oxygen at a temperature below its boiling point, tranquilly and slowly evaporating as water evaporates at moderate temperatures. No ordinary vacuum is of any use. It must be a high vacuum, and Professor Dewar has given a new significance to the phrase; for he has produced vacua measurable in hundred-thousand-millionths of an atmosphere, and by means of which exhaust the largest vessels more quickly than the mercury pump exhausts the smallest.

Many remarkable phenomena were shown on the 20th inst., but none was more worthy of attention than the little bulb of liquid oxygen, something between a walnut and a golf ball, which hung in a clip upon the lecture table. It was filled and hung up at an early period of the lecture, and it remained four-fifths full at the close. If a conjurer had made his appearance with a large kettle of boiling water and a brisk fire beneath, and if in that water he had boiled for half an hour a piece of ice as big as a golf ball without reducing it by more than one-fifth, everyone would have been vastly astonished. But the little bulb full of liquid oxygen was far more wonderful. The difference of temperature between the conjurer's ice and his boiling water is 100° C. The difference between the temperature of Professor Dewar's bulb and the air of the theater was not less than 210° C. Yet, though that scorching blast necessarily had free access to the oxygen in one direction, the liquid was so perfectly protected by its vacuum jacket as to attain that relatively high degree of permanence.

The phenomena shown on the 20th inst. points towards the conclusion that there is no radiation across an absolute vacuum. The crucial experiment would be an hermetically sealed bulb of liquid oxygen self-poised in the center of a perfect vacuum. That experiment we obviously cannot make. When we have done our best there is always some convection between the glass spheres and some direct conduction through their junction besides rapid conduction and convection at the unprotected surface of the liquid. These channels may be fairly held to account for all the heat that reaches the oxygen, and if we assume this to be correct, it seems to follow that the earth swinging free in a perfect vacuum radiates no heat beyond the limit of its own atmosphere.

Not only is liquid oxygen rendered thus susceptible of complete and leisurely examination, but it becomes a valuable means for pursuing further research. It was shown that atmospheric air can be condensed into a liquid at ordinary pressure by the cold of liquid oxygen boiling under the air pump. Liquid air, which was also shown in quantity produced by other means, enables us to effect a further reduction of temperature, and, therefore, an approach to the solution of the tremendous problem of liquefying hydrogen. A gas which occupies weight for weight nearly 15 times the volume of air, and requires for liquefaction a temperature 20 or 30° lower than the lowest yet produced, obviously offers difficulties of an unusual kind. If they are ever overcome it will be due to the great advance we have just described in the methods of storing and manipulating liquid air.

An interesting illustration was given of the essential difference between a liquid and a gas of identical composition. Air liquefies as a whole, the liquid containing oxygen and nitrogen in the normal atmospheric proportions. But when the liquid is allowed to boil it follows the laws of mixed liquids, the nitrogen with its lower boiling point distilling off first and showing no appreciable admixture of oxygen until half of the mass has evaporated. It was also shown by various experiments that liquid air behaves in the magnetic field and in the spectroscope simply as diluted oxygen. Its color is to the beautiful blue of oxygen as the watery sky common in this country to the azure we see through breaking clouds after a storm.

The Market for Gas Securities.

The market for city gas shares was neglected during the week, and Consolidated showed exceptional weakness, the opening price to day (Friday) having been made at 133, showing a net decline for the week of 3 points. No doubt the fear of adverse legislation respecting the gas rate is responsible for the shrinkage, but in our belief there will be no re-adjustment of rates in the State this session of the lawmakers. The Company is doing quite well, although there is marked activity just now in canvassing for customers, as between the Equitable and the Consolidated. In fact, it looks as if the Baron was itching to be taught a new lesson in gas politics, and he is quite likely to have it eventually stored in his memory. The Standard folks are going along quite smoothly, and Mutual shares are firmly held. One depressing feature of the situation is the announcement of "some slight engineering difficulties" in connection with that tunnel of the East River Gas Company enterprise; but the assurance is given that the "difficulties" are soon to be shoved away—in fact, that they (the difficulties) will in the bosom of the deep see be buried.

The Brooklyn situation is still in uncertainty, and quotations, save in the instance of Nassau, Fulton-Municipal, Equity and Williamsburgh, are somewhat lower. In out of town shares, Bay State specialties are weak and lower, the common stock being offered at 50, and the bond issues are also drooping. Chicago gas is quoted at 91, and looks to us to be a purchase. Consolidated, of Baltimore, remains steady, at 62½.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,
16 Wall St., New York City.

February 13.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	133	—
Central	500,000	50	90	95
" Scrip	220,000	—	—	100
Equitable	4,000,000	100	198	200
" Bonds	1,000,000	—	106	108
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	110	115
Mutual	3,500,000	100	142	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	—	—
" Bonds	150,000	—	—	100
Standard Gas Co—				
Common Stock	5,000,000	100	35	40
Preferred	5,000,000	100	88	91x
Yonkers		50	112	—
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	136	139
Citizens	1,200,000	20	108	—
" S. F. Bonds	320,000	1000	—	103
Equity Gas Light Co	2,000,000	100	45	—
Bonds	1,000,000	—	75	80
Fulton Municipal	3,000,000	100	150	152
" Bonds	300,000		102	—
Peoples	1,000,000	10	114	117
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	100	—
Metropolitan	870,000	100	140	—
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	165	—
" Ctfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	155	—
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	85	—
2d " " "	3,000,000	1000	72½	74
Bay State Gas Co.—				
Stock	5,000,000	50	48	50
Income Bonds	2,000,000	1000	78	80
Buffalo Mutual, N. Y.	750,000	100	110	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
Chicago Gas Company.	25,000,000	100	90⅞	91
Chicago Gas Light. & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	85	90½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	101
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Consumers Gas Light Co., Jersey City	2,000,000	100	20	—
Bonds	600,000	1000	80	—
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	190	191
Central, S. F., Cal.			90	—

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